

DETAILED ACTION

Drawings

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: "L1" and "L2". Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: "position sensor L_s". Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be

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labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. **Claims 1-18** are rejected under 35 U.S.C. 102(e) as being anticipated by United States Patent to Unger et al. (6,536,326) directed to a Control System and Method for Preventing Destructive Collisions in Free Piston Machines.

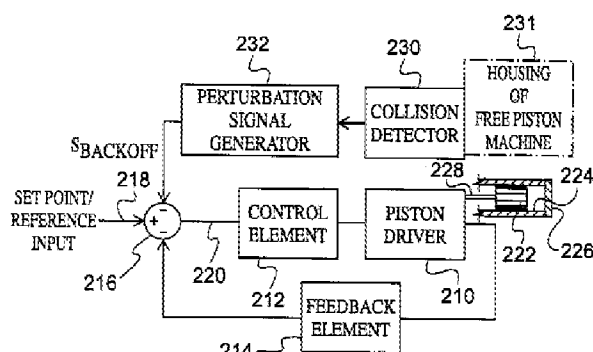


FIG. 2

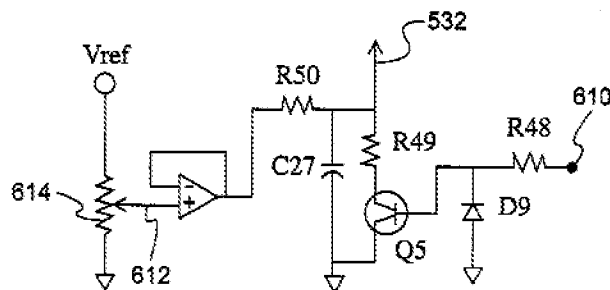


FIG. 6

Regarding Independent **Claim 1**, and in reference to Figures 2 and 6 shown immediately above, Unger et al. (6,536,326) discloses:

A control system (Fig. 2) for controlling the movement of a piston (222) in a fluid-pumping device, the piston (222) being displaceable in a block (224) of the fluid-pumping device and being driven by a motor (210) fed by a voltage, the system comprising: a semiconductor electronic device having an outlet and an inlet, the semiconductor electric device cyclically applying the voltage to the motor (210) to drive the piston (222); a resistive element (R49); a capacitive element (C27); a piston-position sensor (230) to indicate the passage of the piston (222) by a point at the block (224) of the fluid-pumping device; and the system being characterized by: the capacitive element (C27) being electrically connected to the semiconductor device between and re-feeding the outlet and the inlet, the capacitive element (C27) triggering the semiconductor electronic device to apply the voltage to the motor (210); the capacitive element (C27) being charged by means of the resistive element (R49) at each cycle of application of voltage to the motor (210), the capacitive element (C27) being discharged, at least partly, when the piston (222) passes by the point and delaying the trigger point of the semiconductor electronic in a subsequent cycle proportionally to the time of passage of the piston (222) by the point.

Regarding Independent **Claim 10**, and again in reference to Figures 2 and 6 shown immediately above, Unger et al. (6,536,326) discloses:

A method of controlling the movement of a piston (222) in a fluid-pumping device, the piston (222) being displaceable in a block (224) of the fluid-pumping device

and being driven by a motor (210) fed by a voltage, the method comprising the steps of: charging a capacitive element (C27) by means of a resistive element (R49), monitoring the movement of the piston (222) by means of a position sensor (230), and the method being characterized by: maintaining the charge level of the capacitive element (C27) until the position sensor (230) has detected the passage of the piston (222) by a predetermined point at the block (224), and discharging, at least partly, the capacitive element (C27).

Regarding Independent **Claim 14**, and again in reference to Figures 2 and 6 shown immediately above, Unger et al. (6,536,326) discloses:

A fluid-pumping device comprising a piston (222) displaceable in a block (224), the piston (222) being driven by a motor (210) fed by a voltage, and comprising a circuit having a semiconductor electronic device, a resistive element (R49), a capacitive element (C27) and a piston-position sensor (230) to indicate the passage of the piston (222) by a point at the block (224); the device being characterized by comprising: the resistive element (R49) and the capacitive element (C27) being electrically connected with the semiconductor electronic device, re-feeding an outlet and an inlet of the latter; the capacitive element (C27) being charged by means of the resistive element (R49) and being discharged, at least partly, when the piston (222) passes by the point.

As can be seen in the schematic figures shown immediately above, Unger et al.

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discloses a piston control system and method of use for the particular purpose of preventing damaging collisions between the cylinder head 226 and the piston 222. In particular, Unger discloses the basic structure of the system by stating "A piston driver 210 is controlled by a control element 212, with a feedback element 214 supplying a feedback signal from the piston driver 210, or a sensor attached to detect piston or piston driver operation, to a summing junction 216 in the conventional manner. The piston driver is, of course, mechanically linked to a piston 222 for driving it. The piston 222 is slidably mounted within a cylinder 224, having a head 226 forming a cylinder end structure and connected to the piston driver by a connecting link 228. The set point is applied at the reference input 218 in the conventional manner." (Column 5, Lines 7-19) Furthermore, Unger describes (with reference to Figures 4 and 5) the feedback/control process that occurs before the creation of damaging collisions by stating "Like the circuit of FIG. 4, the circuit of FIG. 5 sums a perturbation signal with the feedback signal and the reference input signal, detects a collision of the piston against a cylinder end structure and generates a signal at an output in response to a detected collision. The circuit then varies the magnitude of the perturbation signal in the direction which reduces the piston drive in response to each detection of a collision." (Column 7, Lines 41-48). Also, Unger specifically discloses the charging and discharging of a capacitor used in a capacitor-resistor circuit. In particular, Unger discloses "When the voltage applied at terminal 610 turns off transistor Q5, capacitor C27 charges toward the voltage of the wiper 612 of potentiometer 614 at a rate determined by the resistance of resistor R50 and the upper portion of potentiometer 614. When the output of the

comparator 526 changes states so that the voltage applied at input terminal 610 switches transistor Q5 on, the capacitor C27 is discharged at a rate determined by the RC time constant of C27 and resistor R49. The voltage on the capacitor is the output 532 of the time constant circuit 528 illustrated in FIG. 5" (Column 8, Lines 29-38) Finally, Unger discloses the use of proper capacitors and/or resistors in order to effectively hasten or delay the signal change rate (trigger) of the control circuit. In particular, Unger discloses "The rate of change of the magnitude of the perturbation signal in each direction is determined essentially by the respective time constants for charging and discharging the capacitor C27. This permits the resistance and capacitance values to be chosen respectively so that the rate of change for varying the magnitude of the perturbation signal in a direction which reduces the piston drive in response to detection of a collision may be greater, including considerably greater, than the rate in the absence of detection of a collision. This is desirable so that when a collision is detected, the piston amplitude is rapidly decreased in order to avoid damage. However, the increase of piston amplitude in the absence of collision detection may be considerably slower in order to minimize the occurrence of collisions and yet maintain the piston amplitude near its maximum value." (Column 8, Lines 40-54)

5. In regards to dependent **Claims 2-4, 11, & 15-16**, Unger's circuit is one that is self-feeding, contains a triggering device and bi-directional switch, and recharges a capacitor following initial discharge. With particular reference to Figure 6 above, Unger discloses a self-fed control circuit that utilizes a switching transistor unit Q5 connected

to the capacitor C27 of the control circuit. This transistor Q5 functions both as a triggering device and a bi-directional power switch in that it directly controls the supply to, and charging of, the capacitor C27. In particular, Unger discloses " FIG. 6 illustrates a circuit for accomplishing this purpose. The output of the comparator 526 of FIG. 5 is applied to input terminal 610 in FIG. 6. This input controls transistor Q5. When the voltage applied at terminal 610 turns off transistor Q5, capacitor C27 charges toward the voltage of the wiper 612 of potentiometer 614 at a rate determined by the resistance of resistor R50 and the upper portion of potentiometer 614." (Column 8, Lines 26-33)

Regarding dependent **Claims 5-9, 12-13, & 17-18**, Unger specifically discloses the use of a position sensor designed to continuously detect the position of the reciprocating piston. Unger further discloses that the sensor may be of multiple types including a microphone type sensor and physical contact sensor. In particular, Unger discloses "A feedback element 14, usually a sensor, applies a feedback signal to a summing junction 16 to provide the measured value. The feedback signal can be a function of piston amplitude, piston drive, piston displacement or other parameter which affects or is a function of piston amplitude." (Column 2, Lines 31-36) Unger further discloses "The invention has a collision detector 230 for detecting a collision of the piston, including structures attached to and reciprocating with it, against a cylinder end structure. The output of the collision detector 230 is applied to a perturbation signal generator 232, which in turn has its output, $S_{BACKOFF}$, connected to the summing junction 216." (Column 5, Lines 21-26) Unger also discloses the use of a sensor that physically contact the piston itself. In particular, Unger discloses "As another alternative collision detector, a

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limit switch may be used by physically mounting the limit switch near a cylinder end structure, so that movement of the switch by contact with the piston, or structure reciprocating with the piston, changes the state of the switch and signals a collision at the permissible limits of piston reciprocation. It will be apparent to those skilled in the art that proximity switches and a variety of other means may be used to detect a collision.”
(Column 5, Lines 56-64)

Conclusion

6. The following selected patents and technical literature is cited to further show the state of the art in piston control systems and related technology in general where the not all obvious salient features of the patents are disclosed as follows:

- US Patent Application Publication 2003/0118460 to a Position Sensor and Compressor discloses a piston position sensor that physically contacts the piston in order to control its reciprocation
- US Patent 6,084,320 to a Structure of Linear Compressor discloses a linear compressor/motor unit that contains a piston oscillation controller designed to control the top dead center position of the piston
- US Patent Application Publication 2001/0002977 to an Oscillation-Type Compressor discloses a linear compressor unit designed to minimize the top dead center clearance in order to increase efficiency, while still preventing piston collisions.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ALEXANDER B. COMLEY whose telephone number is (571)270-3772. The examiner can normally be reached on M-F 7:30am - 5:00am EST (Alternate Fridays Off).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Devon C. Kramer can be reached at (571)-272-7118. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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